

Status of AIS Frequencies Nationally and Internationally:

Improving satellite detection of AIS

CG-622 | Joe Hersey
Chief, Spectrum Mgt Div USCG

Technical eXchange on AIS via Satellite (TEXAS II)
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Where things stand – where we're headed – where do we want to go?

- **Both AIS frequencies were originally used for other purposes**
 - What other purposes? How does that legacy affect us now?
 - **Most maritime frequencies, AIS included, are shared with other users**
 - Where? How many? What power? What duty cycle? Can we live with them?
 - **AIS transmissions were never designed for satellite detection**
 - How will growing congestion of the band (e.g. Class B, encrypted STEDS, Search & Rescue, Aids to navigation) affect satellite detection?
 - Is this a problem needing to be addressed? If so, how?
 - **Where do we need to go?**
 - Clear existing AIS frequencies from other uses? Dedicated satellite frequency?
 - Will other Administrations support or oppose these initiatives?
 - Is good engineering practices instead of a regulatory solution sufficient?
-

1997 International Telecommunications Union World Radio Conference

ITU Radio Regulation Appendix 18 – Table of transmitting frequencies in the VHF maritime mobile band (excerpt)

Channel designator	Notes	Transmitting frequencies (MHz)		Inter-ship	Port operations and ship movement		Public correspondence
		Ship stations	Coast stations		Single frequency	Two frequency	
24	<i>m), o)</i>	157.200	161.800		x	x	x
84	<i>m), o)</i>	157.225	161.825		x	x	x
25	<i>m), o)</i>	157.250	161.850		x	x	x
85	<i>m), o)</i>	157.275	161.875		x	x	x
26	<i>m), o)</i>	157.300	161.900		x	x	x
86	<i>m), o)</i>	157.325	161.925		x	x	x
27		157.350	161.950			x	x
87		157.375	...		x
28		157.400	162.000			x	x
88		157.425	...		x
AIS 1	<i>l)</i>	161.975	161.975				
AIS 2	<i>l)</i>	162.025	162.025				

Public correspondence = old marine radiotelephone operator

AIS frequencies are shared with many other users – US and internationally

AIS is in a band of FIXED & MOBILE users

156.8375-174	156.8375-174
FIXED	FIXED
MOBILE except aeronautical mobile	MOBILE
5.226 5.229	5.226 5.230 5.231 5.232

Article 5 - ITU Radio Regulations

1959 World Administrative Radio Conference made it that way

- 287** The frequency 156.8 Mc/s is the international safety and calling frequency for the maritime mobile VHF radiotelephone service. Administrations shall ensure that a guard-band of 75 kc/s on each side of the frequency 156.8 Mc/s is provided. The conditions for the use of this frequency are contained in Article 35.
- In the bands 156.025-157.425 Mc/s, 160.625-160.975 Mc/s and 161.475-162.025 Mc/s, each administration shall give priority to the maritime mobile service on only such frequencies as are assigned to stations of the maritime mobile service by that administration (see Article 35).
- Any use of frequencies in these bands by stations of other services to which they are allocated, should be avoided in areas where such use might cause harmful interference to the maritime mobile VHF radiotelephone service.
-

US Frequency Allocation (*not to scale*)

UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

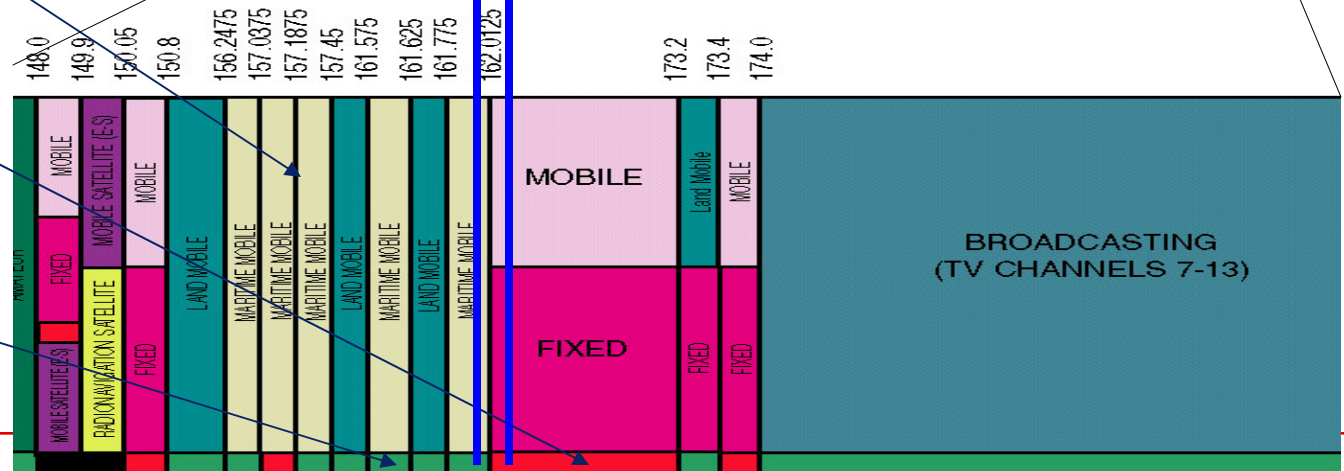


Maritime

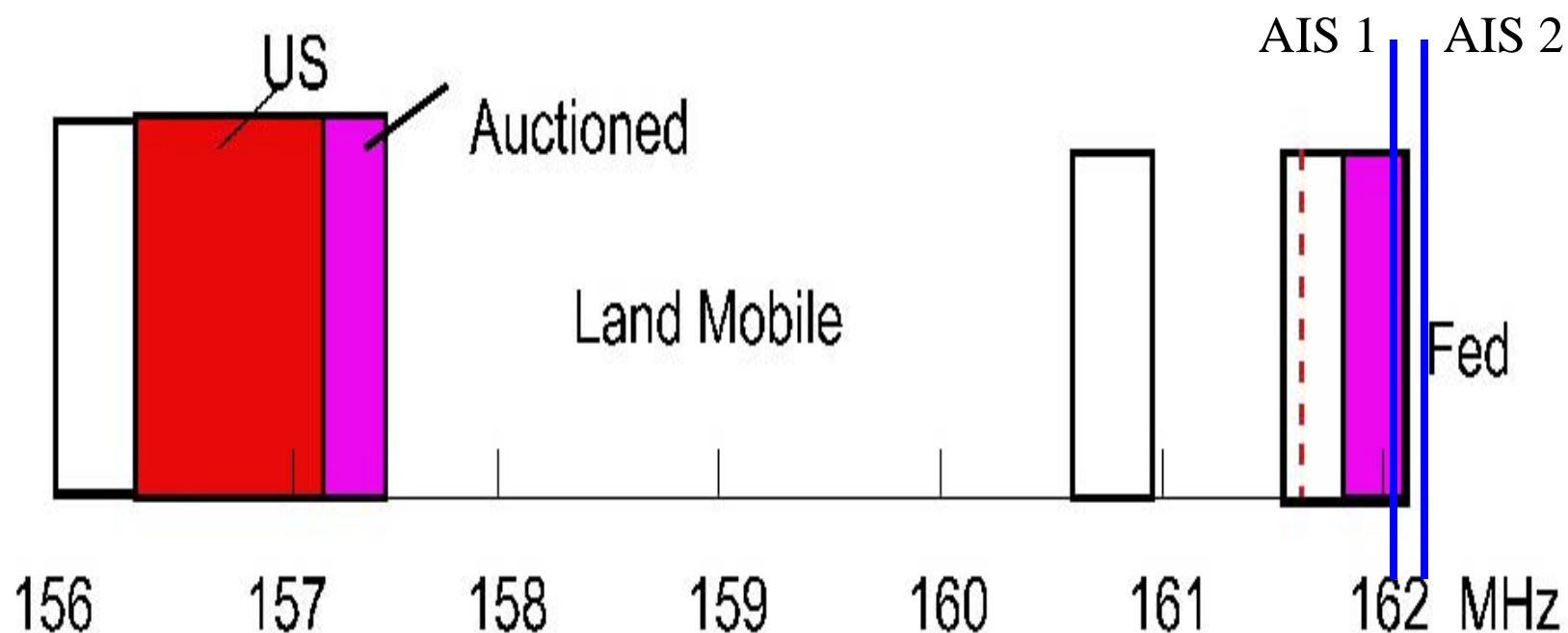
Federal

Non-Federal

AIS 1 AIS 2



International & US VHF Maritime Band (*to scale*)

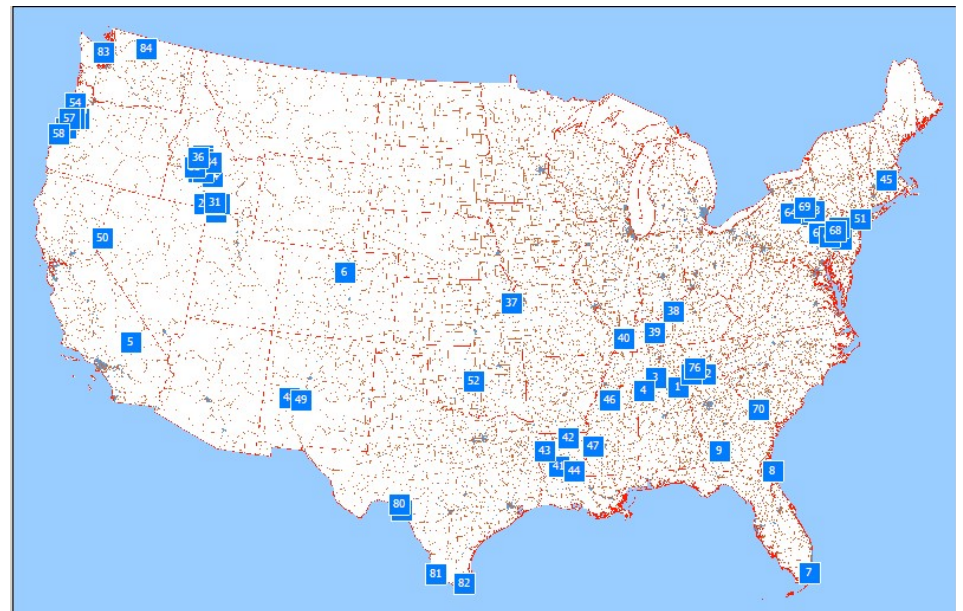


AIS 1 – within band designated for auction in 1999

AIS 2 – within Federal band

AIS 2 is Cleared First

- Before 2004, AIS 2 was a federal land mobile all-government-agency frequency with dozens of users
- Land mobile narrowband mandate enabled this rapid reallocation
- NTIA & its Interdepartment Radio Advisory Committee directed all non-AIS uses be phased out by the end of:
 - **2004:** coastal
 - **2005:** 200 nm of navigable waterways
 - **2006:** All others
 - **Jun 07:** Exceptions & waivers
- **Today this frequency is exclusively AIS nationwide**
 - Others using the frequency don't belong there and must vacate if discovered



Non-AIS licenses in early 2005

Band which included AIS 1 was auctioned in 1999

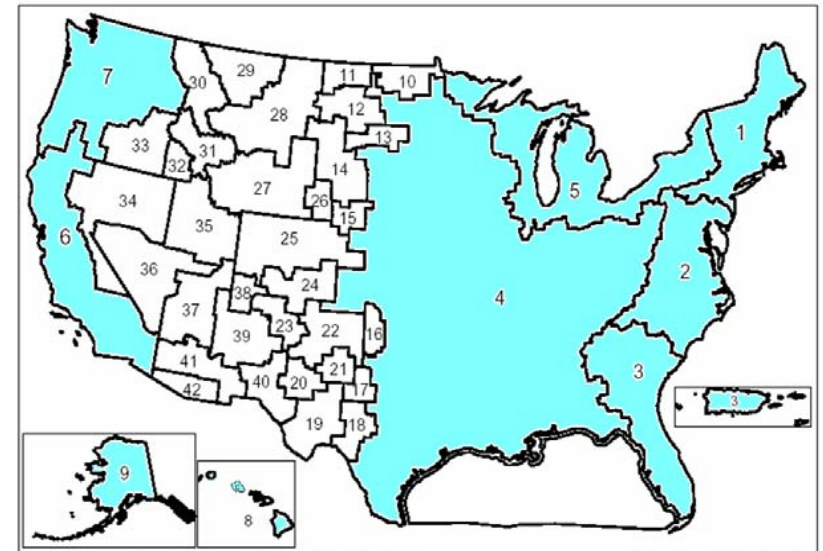
FCC required auction winner & USCG to negotiate AIS frequency

– **March 2001:** FCC Maritime Area auction winner MariTEL – signed MOU establishing an AIS frequency on AIS 1 for (VPCA #1-9)

- **2002-** MariTEL management changed
- **2003-** MOU terminated, filed \$267M claim & complaint in US District Court
- **2004-** Dist. Court dismissed complaint

– **2004 - FCC adopts AIS 1 for AIS exclusively in VPCA #1-9 (similar to MOU)**

- 5 incumbents remain until 2013

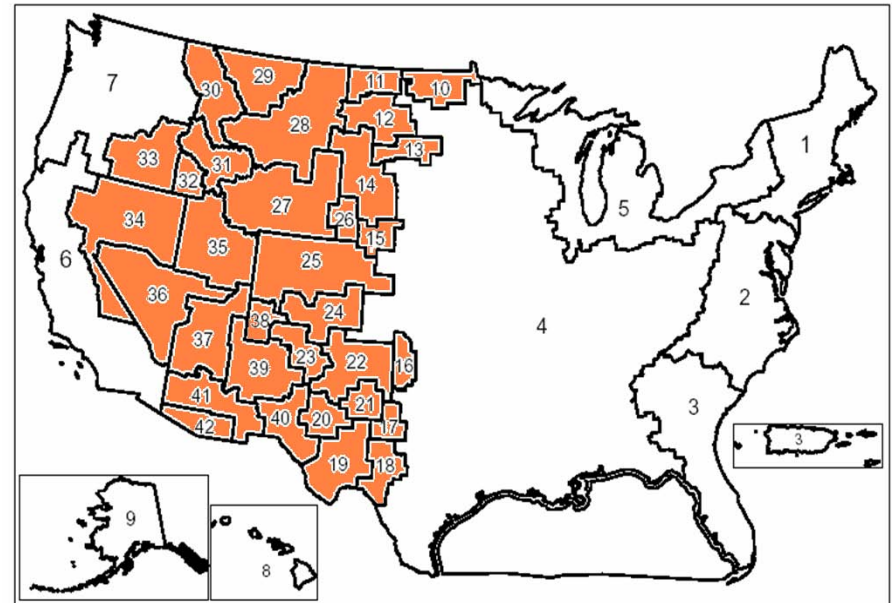


Federal Communications Commission
Wireless Telecommunications Bureau

VHF Public Correspondence Areas #1-9

AIS 1 - What about the Mountain States?

- **VPCSA #10-42 winners not required to negotiate AIS frequency**
 - Required to set aside some frequencies for public safety (not AIS 1)
 - Slowly building out non-AIS systems on AIS 1 and other frequencies
 - numbers of radio sites unknown
 - 7 pre-auction incumbent sites
 - Includes mobiles
 - Most are 50w
- **2004 FCC sought comments on allocating AIS 1 nationwide**
 - Draft Order “On Circulation” since Nov 2007
 - Same Order addresses Class B AIS
 - Decision expected to be favorable



VPC 8 includes BEA 173 Guam and the Northern Mariana Islands and BEA 175 American Samoa
VPC 4 includes BEA 176 Gulf of Mexico

Federal Communications Commission
Wireless Telecommunications Bureau

VHF Public Correspondence Areas #10-42

AIS 2 is cleared US-wide, and AIS 1 may eventually be

- **How many non-AIS radio sites are there currently on AIS 1?**

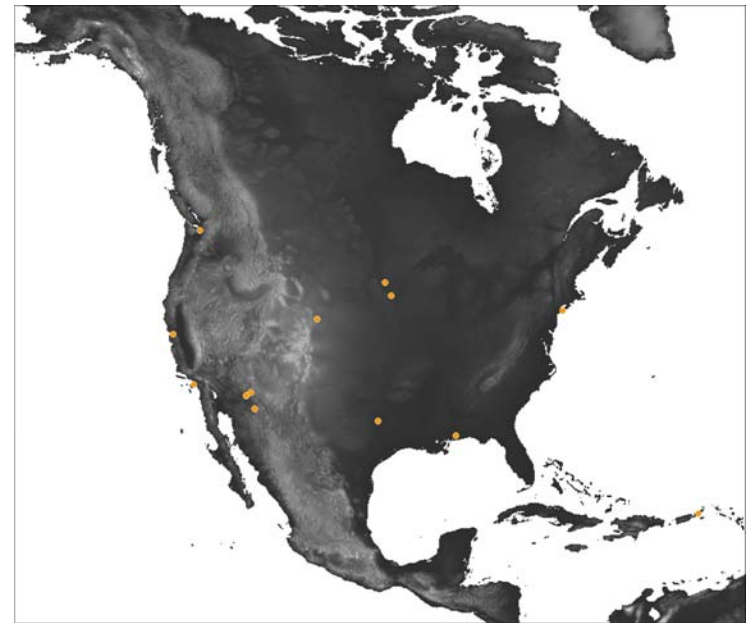
- Don't know for certain, but there should not be many
- Only 12 pre-auction licensees exists
- Number of sites in Mountain Zone auction areas unknown
 - Absent rulemaking, could become large

- **How powerful are these sites?**

- 50 watts into antenna (47CFR80.215)
- USCG will oppose high power waivers

- **Will sites be phased out?**

- Depends upon pending FCC decision
- Note though 10-yr license term and lack of requirement to negotiate AIS frequency



Brown dots are pre-auction
incumbents on AIS 1

What about Canada?

- **AIS 1 & 2 exclusively AIS in all waterway areas**
- **Few non-AIS systems on AIS 1 & 2 in inland areas but there may be some**
 - Some land mobile channels may overlap AIS
 - No documented requirement to clear AIS channels
 - Industry Canada, Nov 2007
- **Good USCG working relationship**
 - with Canadian CG,
 - Transport Canada,
 - Industry Canada &
 - St Lawrence Seaway
 - Though annual radiocommunications meetings with these agencies have been neglected



What about Mexico?

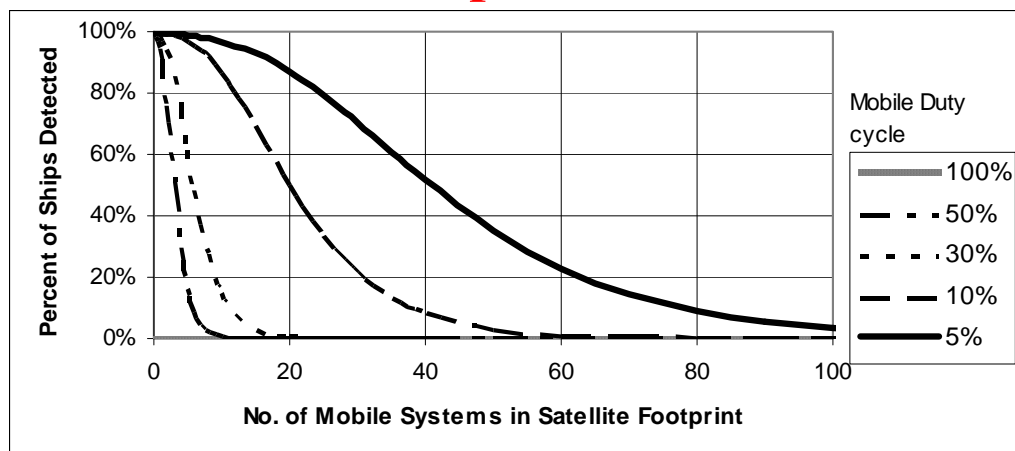
- **Both AIS frequencies available in coastal areas**
 - AIS base stations are being built out
 - Believe significant number of non-AIS users on both frequencies inland
- **State Dept approved negotiation w/Mexico on AIS frequencies**
 - High Level Consultative Commission on Telecommunications
 - Agreement in principal exists to
 - Remove AIS 2 frequency from International Boundary & Water Commission agreement.
 - **Clear AIS 2 nationwide for AIS**
 - Coordinate AIS base stations
 - Negotiations suspended July 08 awaiting replacement of key Mexican personnel



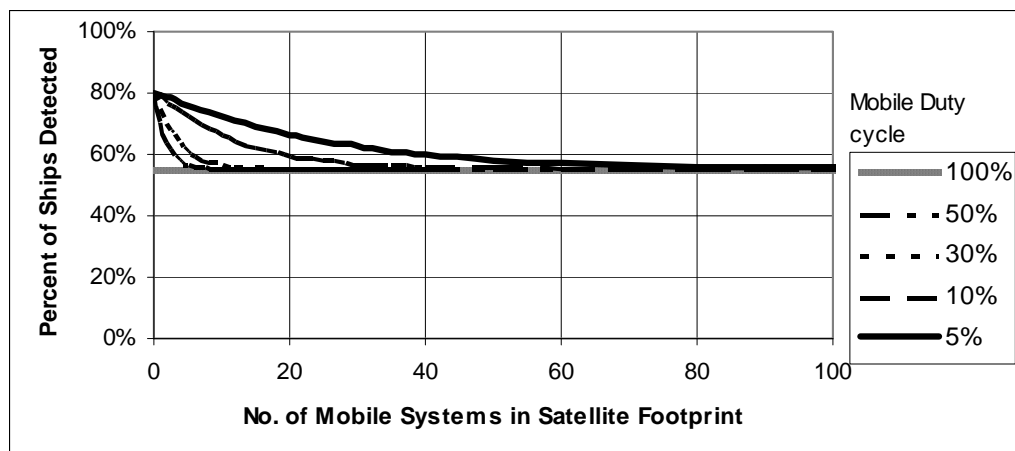
Can AIS frequencies continue to be shared with land mobile users?

Satellite Detection Performance Statistics with Co-Channel Mobile System (ITU-R Report M.2084 – Joint Spectrum Center)

Equal Co-Channel Operation on Each AIS Channel



Satellite Operating at Capacity (80% Detection); Co-channel operation on One AIS channel



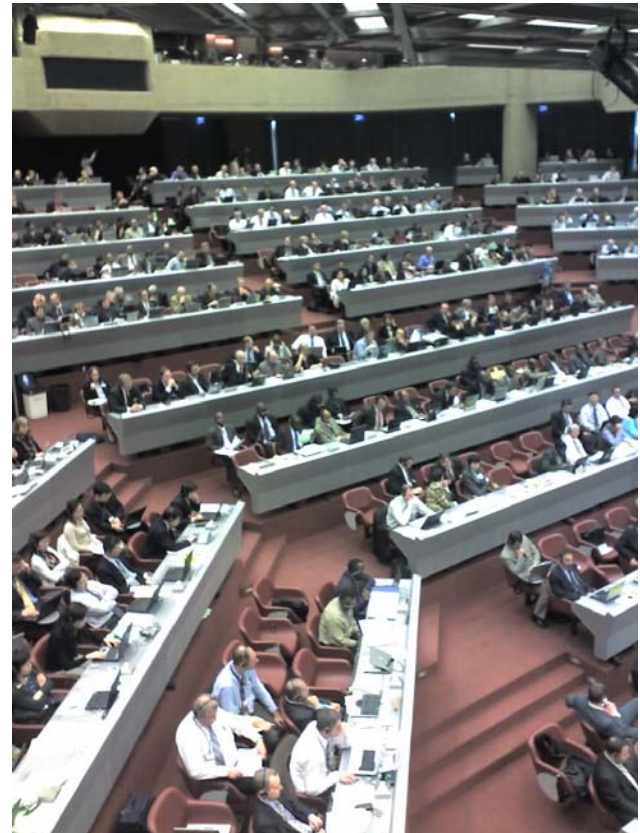
What about the International Telecommunications Union?

- **ITU 2007 World Radio Conference**

- Authorized AIS 1 & AIS 2 as satellite uplink frequencies, on secondary basis
 - Satellite detection now legal, but no protection from radio interference
- Kept matter on agenda for WRC 2011
 - Agenda 1.10 Port & Ship Security

- **ITU Study Group WP5B**

- ITU studies prerequisite to WRC-11 frequency allocation proposals
- Studies include:
 - Adjacent channel interference
 - AIS slot congestion
 - 3rd AIS satellite frequency channel
 - AIS MSG #27 for satellite detection
- No studies yet on impact of reallocating AIS 1 & 2 worldwide for exclusive AIS use



What about the International Maritime Organization?

- **July 2008 Navigation Subcommittee**

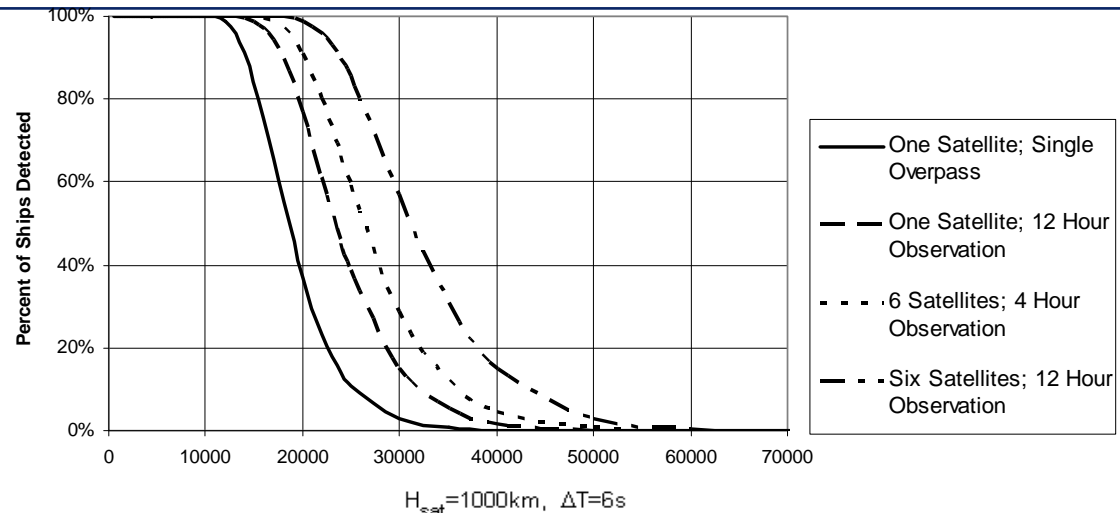
- noted that, up to now, the issue of satellite detection of AIS as such had never been discussed in detail and as such, there was no policy direction on this issue.
- recalled that matters relating to freely available AIS generated ship data and the attendant security risks had been considered previously.
- invited the Committee to **take a clear decision on whether it was supporting the issue of satellite detection of AIS**, taking into account that:
 1. in principle, everyone who would be able to receive these signals could use the information collected, also for commercial activities; and
 2. there might be a need to subsequently specify modifications to the shipborne AIS Class A equipment.

- **Maritime Safety Committee considers the question late November 2008**

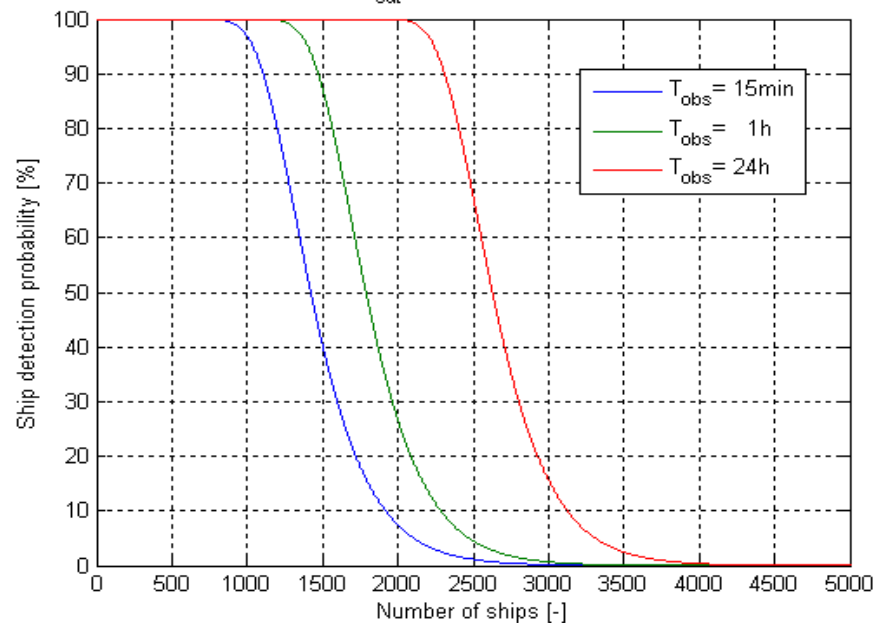


What about AIS slot congestion?

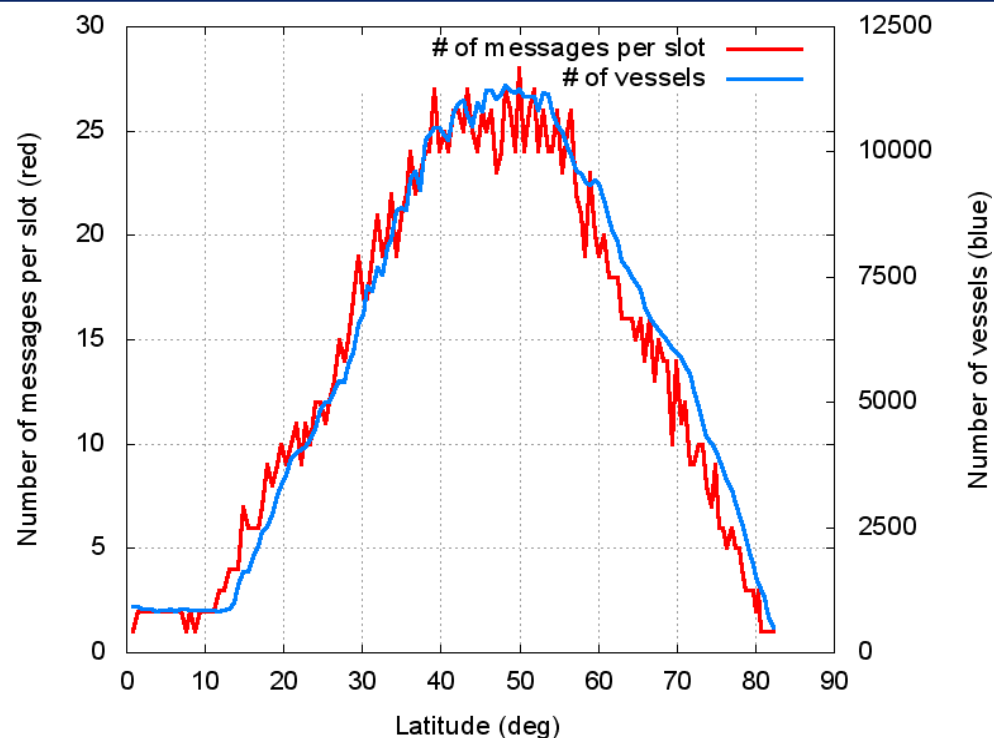
ITU-R Report
M.2084 – JSC,
Target ship located
in the mid Atlantic
Ocean



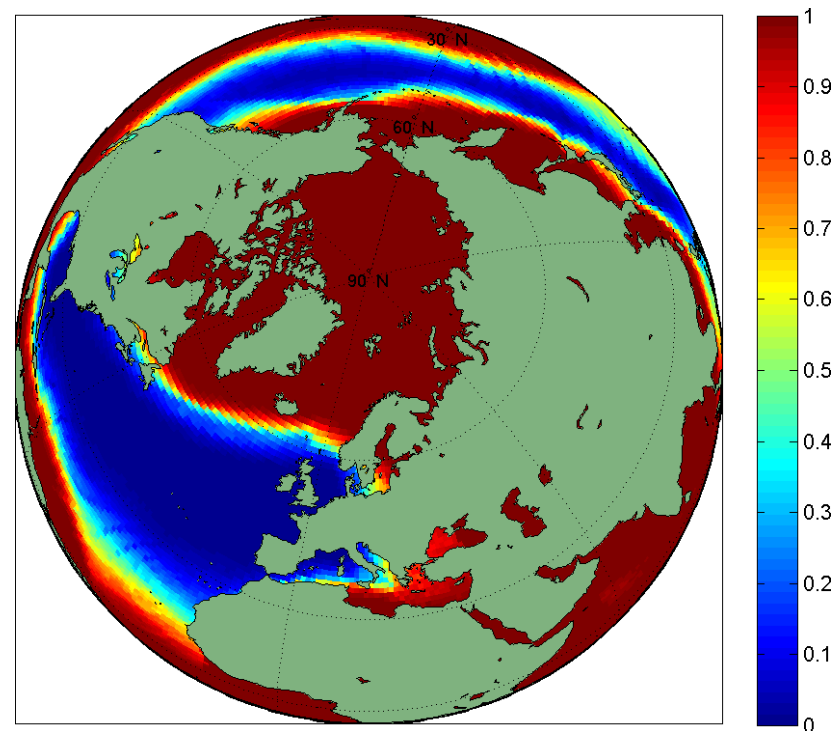
Norwegian Defence
Research Establishment
RTCM 2008 presentation
“AIS Modeling and a
Satellite for AIS
Observations in the High
North)”



How solid is Bjørn Narheim's "wall"?



**Single Timeslot Collision
Rate "AIS as is"**

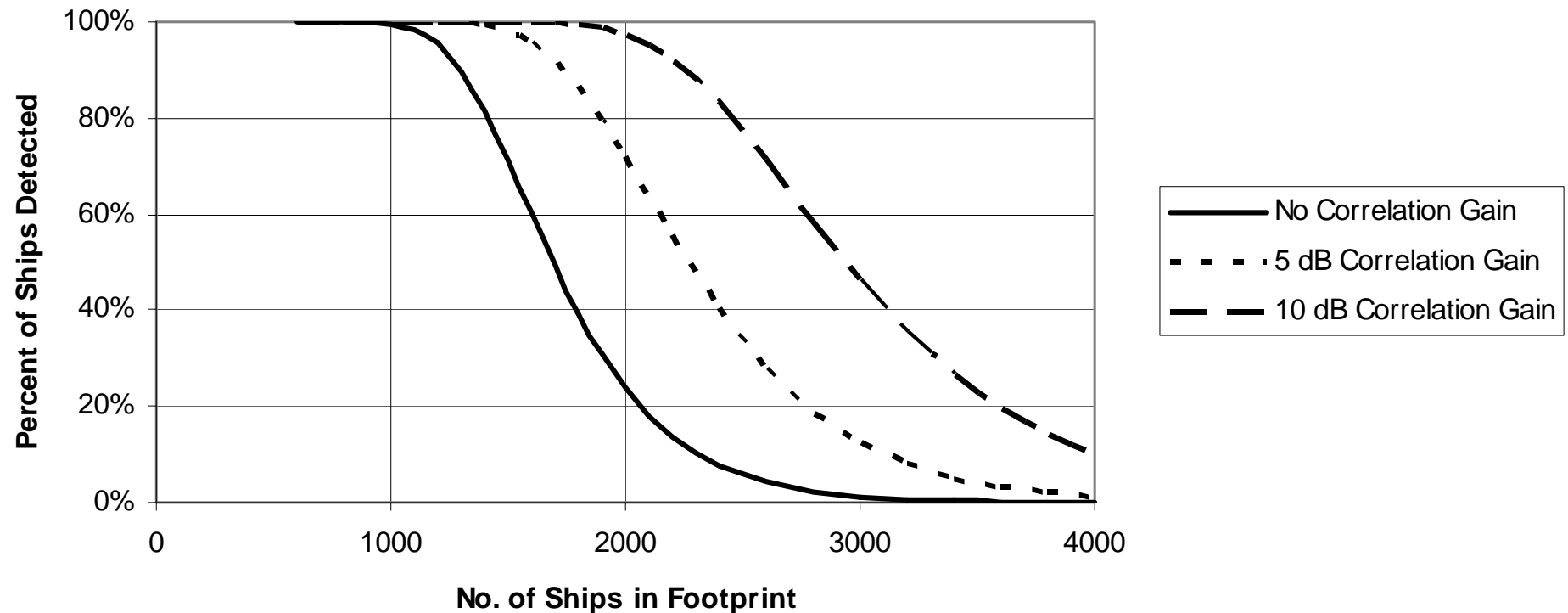


**Daily detection probability for
1 satellite in a 600km polar orbit**

NDRE's RTCM 2008 presentation
"AIS Modeling and a Satellite for
AIS Observations in the High North")"

**How do results
correlate with predictions?**

Satellite Detection Statistics with Correlation Processing – ITU-R Rep M.2084 (JSC)

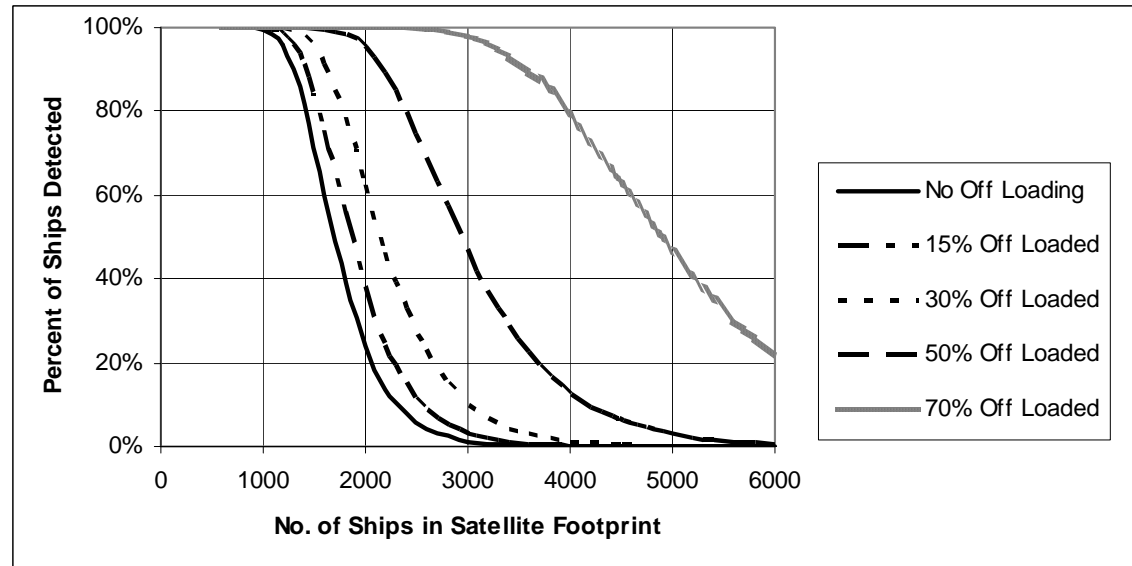


How do results correlate with predictions?

If signal processing cannot handle up to 25 transmissions per slot

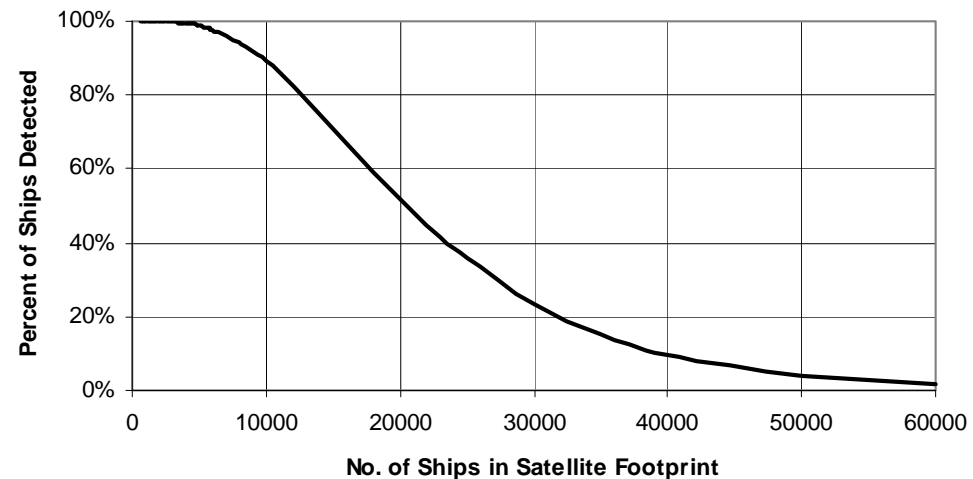
- **Short term:**

Satellite detection
Statistics with Coastal
Offloading of AIS 2
(Rescue21 and/or
NAIS channel mgt)



- **Long term:**

Third AIS
Channel



- [illegible]



- Offload one channel only (i.e. AIS 2)
- Planning must be meticulous
 - Program retained in AIS even after power reset or it leaves the area
 - Program reset in AIS after 5 weeks or 500 nm away from telecommand

Long term - Proposed MSG 27 on exclusive satellite channel

Modified AIS packet bit structure for satellite reception

Slot composition	Bits	Notes
Ramp up	8	Standard
Training sequence	24	Standard
Start flag	8	Standard
Data field	96	Data field is 168 bits for other single-slot messages. This field is shortened by 72 bits to support the satellite AIS system buffer.
CRC	16	Standard
End flag	8	Standard
Satellite AIS system buffer	96	Bit stuffing = 4 bits Synch jitter (mobile station) = 3 bits Synch jitter (mobile/satellite) = 1 bit Propagation time delay difference = 87 bits Spare = 1 bit
Total	256	Standard (NOTE – Only 160 bits are used in the 17 millisecond transmission)

Proposed new data field for AIS satellite detection – Message 27

Parameter	Number of bits	Description
Message ID	6	Identifier for this message (similar to all other messages)
Repeat indicator	2	Repeat indicator value should be 3
User ID	30	MMSI number
Position accuracy	1	As defined for Message 1
RAIM Flag	1	As defined for Message 1
Navigational status	4	As defined for Message 1
Longitude	18	Longitude in 1/10 min ($\pm 180^\circ$, East = positive, West = negative)
Latitude	17	Latitude in 1/10 min ($\pm 90^\circ$, North = positive, South = negative)
SOG	6	Knots (0-62); 63 = not available = default
COG	9	Degrees (0-359); 511 = not available = default
Status of current GNSS position	1	0 = Position is the current GNSS position; 1 = Reported position is not the current GNSS position = default
Spare	1	Set to zero, to preserve byte boundaries
Total number of bits	96	

• proposing channel 16 guardband Channel 75 or 76

• 3 minute reporting interval

How essential is it to clear AIS 1 & 2 of other users?

- **Within the US**

- Should the move off AIS 1 be speeded up? (That may require funding)
- It could require asking FCC Commissioners to speed decision (draft rule “in circulation” since Nov 2007)

- **Within North America**

- Should we begin negotiations with Canada? With others? (Mexico on hold)

- **Internationally**

- Should we propose at WRC 11 that AIS 1 & 2 be exclusive AIS worldwide?
 - Would require active support from interested parties (satellite providers, DoD and Administrations outside US) to succeed
 - Would require funding for ITU studies
 - Opposition from land mobile radio community
-

How essential is it to address slot congestion problem?

- **What affect will Class B population have?**
 - USCG NPRM Vessel Requirements for Notices of Arrival and Departure, and Automatic Identification System (USCG-2005-21869)
 - Should satellite detection of Class B AIS be encouraged or discouraged?
 - Note authorization of Class B also held up by FCC Commissioners
 - **What affect will uncontrolled binary message / BFT population have?**
 - **How essential will a third AIS channel for satellite detection be? What should the US position be?**
 - Note IMO & International Chamber of Shipping concerns
 - Would require active support from interested parties (satellite providers, DoD, Administrations outside US) to succeed
 - May require existing Class A AIS units be modified
-

